PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements relating to Turbine Rotor Blades

I, GEORGES BOLSEZIAN, of Bulgarian nationality, of 7, rue de Constantinople, Paris, France, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

This invention relates to blades for rotors of high temperature elastic fluid turbines, and particularly to hollow and assembled blade structures.

The purpose of the invention is to provide hollow blades having an improved resistance to centrifugal and thermal stresses.

According to the invention, a hollow blade for rotors of high temperature elastic fluid turbines is composed of an assembly of at least three elements one of which is an at least partly inner element and at least two of which are outer elements in contact with the hot gas, each of said outer elements forming an empty space around the corresponding inner part of said at least partly inner element, and every leading edge or portion of the leading edge and every trailing edge or portion of the trailing edge of the blade having both its front face and its back face on the same element, and means being provided for passing a cooling medium through said empty spaces.

Other features of the invention will be apparent as the description proceeds, and when taken in conjunction with the accompanying drawings, wherein :

Fig. 1 illustrates a cross-sectional view of a blade according to the invention, in the general plane of the rotor ;

Fig. 2 is a sectional view of the blade shown in Fig. 1, taken as indicated by the line II–II of Fig. 1 ;

Fig. 3 is a view similar to Fig. 2, illustrating a modification made preferably of ceramic material ;

Fig. 4 is a view perpendicular to the rotor axis of a second form of blade according to the invention ;

Fig. 5 is a cross-sectional view in the plane of the rotor of a third form of blade according to the invention ;

Fig. 6 is a sectional view of the blade shown in Fig. 5, taken through the line VI–VI of Fig. 5, at the root part of the blade.

Now referring to Fig. 1, there is shown a blade according to the invention which comprises a composite structure including two shorter blade elements 1 and 2 radially arranged in series relationship to each other, together to form the complete blade. The first blade element 1 is integral with the root 3 of the blade, which root is secured through any suitable means on the rotor structure of the turbine. The other blade element 2 is free at the end thereof engaging the outer end of the blade element 1 and said element 2 is secured at its outer end to a rod or support 4 of any suitable shape in cross-section. The rod 4 is secured to the root 3 of the blade element 1 or directly to the rotor by any suitable means such for instance as a screw connection, as shown at 12, or a dove-tail connection at its base. The outer blade element 2 is secured to the internal support 4 by any appropriate means which may, as shown, include a shroud 6 and a rivet 5, forming an abutment, or it may be welded to the rod 4. The rod or support 4 is isolated from the hot parts 1 and 2 by the provision of an empty space 7.

A flow of cooling air enters the empty space 7 through one or more inlet apertures such as 10 and escapes through slots 11 formed in the blade element 2, as shown in section in Fig. 2, thus cooling the elements 1, 2 and 4 and also serving to blow off the boundary layer at 11.

Since the lower blade element 1 is much shorter than would be a solid blade of equal over-all length to the composite blade structure 1–2, the stresses created at its root portion by centrifugal force are much lower, and consequently the resistance of said short blade element 1 at high temperatures will be much greater. The fact that the blade is cooled further increases its

[*Price* 2/-]

resistance. The blade element 2, which is also much shorter than would be a solid blade of similar over-all length, is also less stressed by centrifugal force and its resistance is thus also increased. The blade element 2 is stressed in compression by centrifugal force at its outer end. The supporting member or rod 4 is stressed by its own weight and that of the blade element 2 and the stresses therein are therefore greater. However, since the member 4 is efficiently isolated against any type of heat transmission and is moreover fluid-cooled, said member is kept cool and is adapted to resist more satisfactorily such higher stresses.

The interengaging ends of the blade elements 1 and 2 form a friction fit at their telescopically interengaging end portions 8 and 9. When cool, the ends 8 and 9 have a radial clearance to allow expansion of the blade elements 1 and 2. The purpose of the provision of a friction fit between the telescoping ends 8 and 9 towards the middle of the blade structure is to damp the vibration in the blade.

The blade element 2, which is stressed in compression by centrifugal force, may advantageously be formed of a suitable ceramic material possessing a high compression strength. This is shown in cross-section in Fig. 3, in which the supporting rod 4 is shown as formed with a blade-like profile and the blade element 2 is formed of two halves 2′ and 2″ of ceramic material separated at the longitudinal gaps 11′ and 11″. The halves 2′ and 2″ are assembled at their outer ends by means of a metallic cup member or the like and at their inner ends by the blade element 1.

Fig. 4 shows a second form of blade according to the invention. The blade is formed by three elements, of which two are outer elements 25 and 26, while 22 is a partly inner element which is longer than said outer elements and completely isolated from the hot gas at its root part by said outer elements 25 and 26 and an empty space similar to that shown at 7 in Fig. 1, said element 22 having an upper part which projects into the gas stream and forms together with the elements 25 and 26 the aerodynamically active part of the blade. The elements 25 and 26 form each half of the blade profile and are separated at the gap 29. They are assembled only at their root by a weld 28, at the lower part of the gap 29. The cooling air enters through holes, not shown, at the base 32 of the blade, and escapes through the not welded part of the gap 29. The outer elements 25 and 26 are fixed on the rotor by any suitable means, as for example a fir-tree connection 27, and the inner element 22 is fixed on the root of the outer elements by any suitable means. The cooling air arrives through a hole 30 in the rotor 31.

The elements 25 and 26, being shorter than the entire blade, are stressed less by the centrifugal force, and being also cooled internally, they resist better than a longer blade. The inner element 22 has the same length as the entire blade, but only its upper part is in contact with the hot gas, and as this upper projection is shorter and transmits one part of the heat to the lower cooler part, its resistance is greater.

Figs. 5 and 6 show a third form of blade according to the invention. This blade is formed by three elements. The first is a partly inner element having a central core 37 which is shorter than the entire blade length and isolated from the hot gas, and which is integral with the root 38 of the blade and with its leading and trailing edges 45 and 46. The blade is thus entirely hollow at its upper part. Two outer elements 42 and 43, formed by profiled sheets, are assembled with said partly inner element by welds at 44, so as to isolate the central core 37 and to form empty spaces 40 and 41 which are traversed by a flow of cooling air entering through the holes 39 at the root and escaping at the tip.

The shorter central core 37, which is isolated and cooled, has a greater resistance and, being integral with another longer and hotter part of the blade, said central core serves as a support for it, thus increasing the total resistance of the blade.

What I claim is:—

1. A hollow blade for rotors of high temperature elastic fluid turbines, which is composed of an assembly of at least three elements one of which is an at least partly inner element and at least two of which are outer elements in contact with the hot gas, each of said outer elements forming an empty space around the corresponding inner part of said at least partly inner element, and in which every leading edge or portion of the leading edge and every trailing edge or portion of the trailing edge has both its front face and its back face on the same element, means being provided for passing a cooling medium through said empty spaces.

2. A blade as claimed in claim 1, wherein the outer elements are hollow and comprise each a portion of the leading edge of the blade and the corresponding portion of the trailing edge of the blade, are placed in series relationship to each other and form empty isolating spaces around an inner element the height of which is substantially equal to the sum of the heights of said outer elements, the lower of said outer elements being fixed on the rotor by its root and the upper of said outer elements being supported by said inner element.

3. A blade as claimed in claim 2, wherein said hollow upper outer element is formed of

ceramic material which is stressed in compression.

4. A blade as claimed in claim 2 or 3, wherein said hollow upper outer element is formed by two longitudinal parts assembled at their lower and upper ends, the leading edge of said upper outer element being formed entirely on one of said parts and the trailing edge of said upper outer element being formed entirely on the other of said parts.

5. A blade as claimed in claim 1, wherein said two outer elements are adjacent longitudinal elements, each forming an empty space around an inner element, the leading edge being formed on one of said outer elements and the trailing edge being formed on the other outer element, and said two outer elements being welded together at their roots.

6. A blade as claimed in claim 5, wherein said inner element is prolonged above said outer elements, its upper part projecting into the gas stream to form together with said outer elements the entire blade profile.

7. A blade as claimed in claim 1, wherein the root and the leading and trailing edges of the blade are integral parts of the partly inner element and wherein two outer elements are placed each on one face of the blade, said outer elements being spaced from said leading and trailing edges and forming empty isolating spaces around the central portion of said partly inner element, and the surfaces of the leading and trailing edges and the surfaces of said outer elements forming together the entire blade surface.

8. A blade as claimed in claim 7, wherein said outer elements are welded on the partly inner element.

9. A blade as claimed in claim 7, wherein said isolated central portion of the partly inner element is shorter than the entire blade length.

10. A blade as claimed in claim 2, 6 or 7, wherein a portion of the blade in contact with the hot gas is supported by the isolated and cooled part of the at least partly inner element.

11. A hollow blade for rotors of high temperature elastic fluid turbines, substantially as described with reference to the accompanying drawing.

Dated this 9th day of July, 1948.

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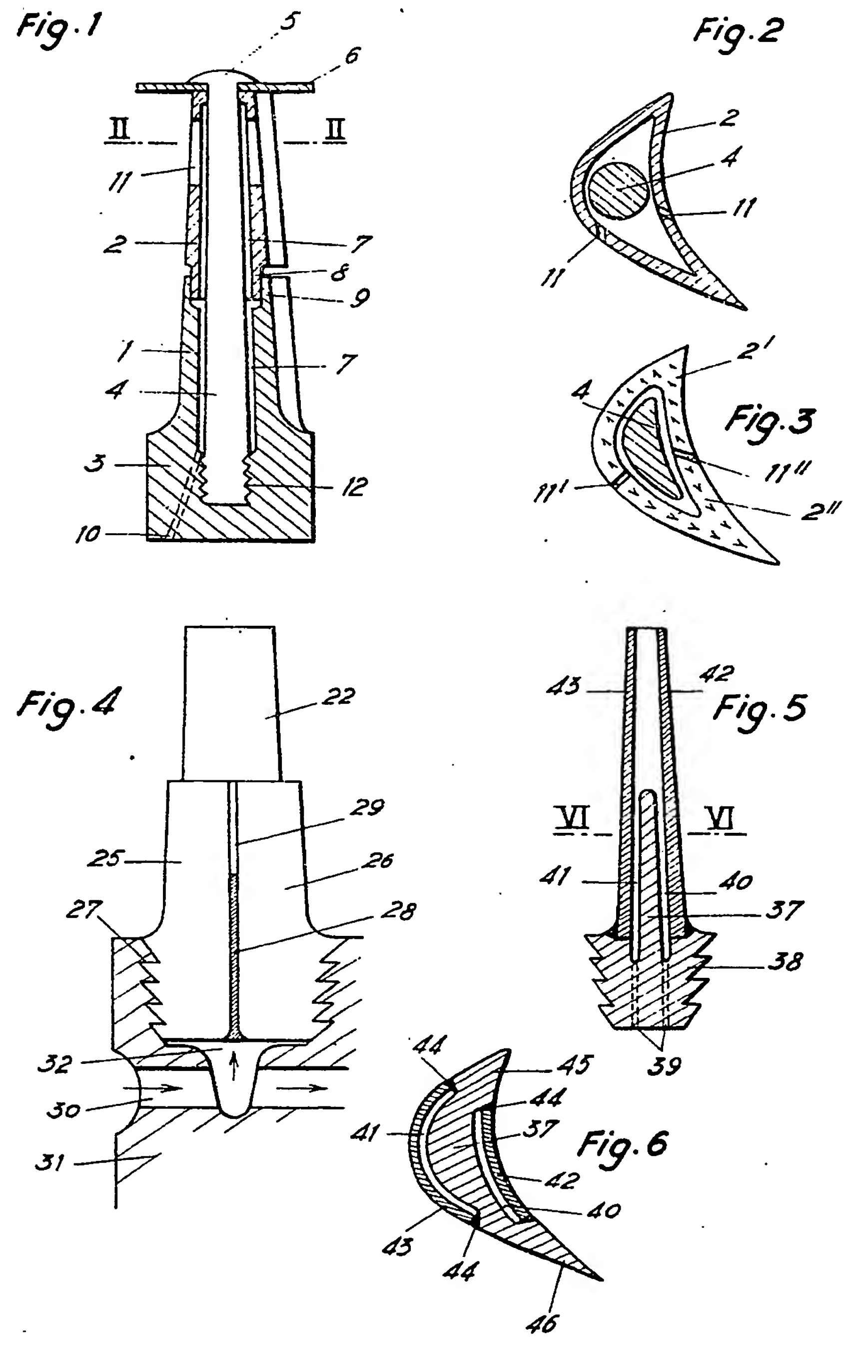
Fig. 1
5
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II
II
11
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7
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4
3
12
10
Fig. 2
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4
11
11
2'
4
Fig. 3
11''
11'
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Fig. 4
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Fig. 5
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VI
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Fig. 6
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